The Impact of Artificial Intelligence on the Decision-Making Process of a Real Estate Company

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Dissertation submitted in partial fulfilment of requirements for the MSc in Management with Specialization in Strategic Marketing, at the Universidade Católica Portuguesa, January 2022.

Abstract

Title: The Impact of Artificial Intelligence on the Decision-Making Process of a Real Estate Company

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For a real estate company, it is harder to adapt to current developments compared to other industries, as they have longer investment cycles and therefore greater consistency and more time to adjust. However, new technologies could help to solve some of the challenges faced during the decision-making process. In theory, AI tools have various advantages; yet, in practice, such systems are more difficult to implement. The underlying work explores how a real estate company is responding to the rapidly changing environment and implementing new technologies. According to the findings of the qualitative research conducted – which includes 10 interviews with employees of a selected real estate company and secondary data from journal articles, books and online sources – most of the AI tools are currently still in the testing phase. The key benefits discovered during the research include increased productivity as a result of faster, more efficient, and effective decision-making. However, when implementing new systems, the company must define several factors, including technical and cooperative compatibility. The results suggest that, in the future, AI will take a more central role in real estate companies, whereas it currently only acts as a decision support system. In general, the application of AI, resulting in an improvement of the decision-making process, might have a positive impact on the overall performance of the real estate company.

Keywords: Artificial Intelligence, Decision-Making Process, Real Estate Industry, Technology

Sumário (Portuguese version)

Título: O Impacto da Inteligência Artificial no Processo de Tomada de Decisão de uma Empresa Imobiliária

Autor: Melanie Ochs

Para uma empresa imobiliária, é mais difícil adaptar-se aos desenvolvimentos actuais do que a outras indústrias, uma vez que têm ciclos de investimento mais longos e, portanto, maior consistência e mais tempo para se adaptarem. Contudo, as novas tecnologias poderiam ajudar a resolver alguns dos desafios enfrentados durante o processo de tomada de decisão. Em teoria, as ferramentas de IA têm várias vantagens; no entanto, na prática, tais sistemas são mais difíceis de implementar. O trabalho subjacente explora a forma como uma empresa imobiliária está a responder ao ambiente em rápida mudança e a implementar novas tecnologias. De acordo com os resultados da investigação qualitativa realizada - que inclui 10 entrevistas com empregados de uma empresa imobiliária seleccionada e dados secundários de artigos de revistas, livros e fontes em linha - a maioria das ferramentas de IA ainda se encontra actualmente em fase de teste. As principais vantagens descobertas durante a investigação incluem o aumento da produtividade como resultado de uma tomada de decisão mais rápida, mais eficiente e eficaz. No entanto, ao implementar novos sistemas, a empresa deve definir vários factores, incluindo a compatibilidade técnica e cooperativa. Os resultados sugerem que, no futuro, a IA assumirá um papel mais central nas empresas imobiliárias, enquanto que actualmente actua apenas como um sistema de apoio à decisão. Em geral, a aplicação da IA, resultando numa melhoria do processo de tomada de decisão, pode ter um impacto positivo no desempenho global da empresa imobiliária.

Palavras-chave: Inteligência Artificial, Processo Decisório, Indústria Imobiliária, Tecnologia

Acknowledgements

This dissertation symbolizes the end of one chapter and the beginning of a new one in my life. All of the experiences I have had, all of the people I have met, and all of the knowledge I have gained over the previous few years have had a significant impact on me and have greatly aided in the construction of this dissertation as a critical step in my personal and professional development. I would like to thank everyone who believed in me and helped me become the person I am today. I want to express my gratitude to the following people in particular:

I would like to thank my supervisor *Professor Cristina Mendonça* who supplied valuable feedback and therefore enabled me to enhance my work on a continual basis. Thank you for your great supervision, your continual availability and dedication, and for all of your knowledge sharing, explanation of doubts, and assistance throughout this dissertation.

My gratitude goes out to *all interview participants* who contributed their professional expertise to my thesis. The research questions could be answered based on the information provided. Thank you very much for taking the time to share your insights with me!

Special thanks go to *Benjamin and my roommates Carla, Lea, and Valerie,* who contributed to my well-being by motivating, guiding, and supporting me as well as providing moments of rest and amusement. We shared all the moments of sadness and anxiety in difficult days, but also celebrated every small accomplishment and the happiest moments of this journey together.

Above all, I want to thank *my family, friends, and closest colleagues* who supported and encouraged me during the whole time of my studies. My accomplishments would be less meaningful if they weren't shared with all of them. My parents deserve special recognition for their unwavering support in helping me get to where I am today. Knowing how proud they are of me is overwhelmingly inspiring and motivates me to continue pursuing my goals. Without this great group of people by my side, this journey would not have been the same.

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List of Abbreviations

AI	Artificial Intelligence
CEO	Chief Executive Officer
CIO	Chief Investment Officer
DSS	Decision Support Systems
e.g.	for example
Ed.	Edition
et al.	and others
Etc.	etcetera
IoT	Internet of Things
IDSS	Intelligent Decision Support Systems
IT	Information Technology
ML	Machine Learning
n.d.	no date
RQ	Research Question
Vol.	Volume

1. Introduction

1.1. Background and Problem Statement

The rise of data-based technologies in recent years has disrupted several industries and helped organizations to define more successful organizational processes (Di Vaio et al., 2021). Every industry is learning to reap the benefits of analyzing data, and it appears that discovering new ways to collect, record, and analyze the data will continue to be a big part of businesses in the near future. Each step of a process can be recorded so that improvements can be made as needed, which also enables companies to respond more effectively to shifting needs by using the collected information. (Marr, 2015) The volume of datasets is beyond the ability of standard technology or human mind to handle and interpret as the amount of data collected grows exponentially (McKinsey Global Institute, 2011). Artificial Intelligence (AI) is currently experiencing a rapid expansion (Duan et al., 2019) as it can assist in the analysis of large unstructured datasets, allowing it to make more accurate, faster, and consistent decisions or predictions. Adding AI processes to a business is supposed to increase more than just profits and revenues. With the use of AI, huge amounts of complex data can be turned into tangible outcomes which create business value and ensure efficient and effective decision-making. (Ajah & Nweke, 2019) McKinsey forecasts that by 2030, approximately 50% of all big companies' processes will include AI systems and about 70% of businesses will be applying at least one AI tool (Bughin et al., 2018).

By investing in AI, companies can redesign systems, processes, and strategies. Common uses for using AI are: developing more intelligent products or services (e.g., self-driving cars), making processes smarter (e.g., border control agents), or automating tasks in businesses (e.g., customers support agents) (Marr, 2015). Also, in the real estate industry, AI has the potential to improve and provide opportunities for the decision-making process (Chaillou et al., 2017). Especially real estate and construction management projects are becoming more and more complex with the different interests of stakeholders, tighter budgets, and less time to finish the projects than before (Eber, 2020). The difficulty is to make the best use of the available data and to gather the key insights that are required for the decision-making process (Marr, 2015). Special analytics tools, such as machine learning, neural networks, and deep learning, aid in the structure and intelligent use of data. The ability to employ these technologies in a variety of areas, such as forecasting, will be transformative for the real estate sector. (Chaillou et al., 2017) According to research from McKinsey Global Institute, the real estate sector is,

compared to other sectors, well-positioned for greater gains from using big data. This is because, despite the fact that data is sometimes limited or difficult to obtain in this area, real estate decisions are mostly based on data that has been examined and interpreted. (McKinsey Global Institute, 2011)

The impact of AI systems on the procedures employed in real estate companies' decision-making processes has yet to be investigated. As a result, examining the AI tools used in real estate decision-making and their impact on these processes fill a gap in the academic literature from a business perspective.

1.2. Research Objectives

This thesis aims to identify the opportunities and challenges of using AI systems for decision-making processes in the real estate industry, more particularly from a company's perspective. Therefore, the problem statement can be defined as follows: How does AI impact the decision-making process of a real estate company? To answer this question, this dissertation will deeply analyze the decision-making processes in a real estate company and find out in what departments and for what decisions AI is currently used. First, the decision-making process will be discussed generally, subsequently focusing on the parts where AI is implemented, the challenges faced, and the opportunities provided.

The problem statement will be researched through the following specific research questions:

RQ1: How is the decision-making process in real estate companies structured?

RQ2: What are the key challenges in the decision-making process?

RQ3: What AI tools are currently used?

RQ4: How can AI impact the decision-making process? What opportunities does it provide?

RQ5: What challenges arise in using AI in the decision-making process and how can they be solved?

RQ6: What decisions are we willing to permit computer systems to make autonomously? What decisions are we not willing to let AI decide autonomously and why?

1.3. Outline

To begin, an overview of a decision-making process model is presented. The definition of AI is then explained, followed by an overview of various AI applications and how AI and humans interact in decision-making. Also, the factors that companies evaluate while determining whether or not to invest in AI are discussed. Following that, the real estate sector will be addressed, as well as the decision-making process in real estate companies and the usage of AI in this industry. To gain a more in-depth understanding of the subject, the decision-making process of a real estate company is investigated, with an emphasis on the current status of AI implementation and the impact of AI on the process. Finally, autonomous decision-making and future trends are discussed.

2. Literature Review

2.1. Decision-Making

Decisions are a natural part of life. In a business context, they can be a crucial aspect of becoming successful. (Uzonwanne, 2016) In the Cambridge dictionary, decision-making is defined as "the process of making choices, esp. important choices" (Cambridge Academic Content Dictionary, 2021). Depending on the decision situation, four different types of decision-making models were proposed (Scott & Bruce, 1995). The decision-maker relies on others for support and guidance when using the *dependent* decision-making style. Making decisions oriented on feelings, relatively fast and with limited information leading to assumptions can be defined as the *intuitive* decision-making style. The characteristic of the *avoidant* decision-making style is trying to avoid making decisions overall. The *rational* decision-making style is characterized by a logical evaluation of alternatives (Scott & Bruce, 1995) and hence is a more advanced type of decision-making. The intuitive, dependent, and avoidant styles are more commonly utilized on a daily basis since they are quicker, do not require investigation, and do not necessitate the gathering of facts. Everyday decisions include things like deciding which route to travel to work in a busy city on a crowded day or selecting a dinner dish from a menu of multiple alternatives. (Uzonwanne, 2016)

The focus for this thesis will be on the rational decision-making style, as it is the most appropriate style for more serious decisions (Uzonwanne, 2016). Since important decisions are mainly built upon facts and evaluation (Simon, 1997a), the rational decision-making style is an effective and functional decision-making tool for higher-level decisions applied by leaders and

managers (Oliveira, 2007). The definition of rationality, which is the "compatibility between choice and value" (Oliveira, 2007, p.13), implies that during the rational decision-making process, several possible scenarios or situations are evaluated before a choice is selected (Simon, 1997a). Since the subject is viewed from various angles during the process, and a logical approach is used to analyze and organize facts, the final choice is regarded as the one with the best predictable outcome or consequence (Oliveira, 2007) and can therefore guide accurate decision-making (Uzonwanne, 2016).

A generally accepted rational decision-making process was developed by Simon (1997a), which consists of four phases (see Figure 1). In the first phase, the *intelligence phase*, information is gathered, and a basic understanding of the problem is developed. In the second phase, the *design phase*, criteria are identified, a model is developed, and alternatives are investigated. During the *choice stage*, which is the third phase, alternatives are weighed, and a selection of alternatives is made depending on which one best supports the decision criteria. Lastly, along with the *implementation phase,* the decision is followed up on and learnings can be drawn from it. During each phase, feedback loops embedded in the system are used to identify problems that arise to know when a step needs to be taken back to evaluate the scenarios. (Simon, 1997b)

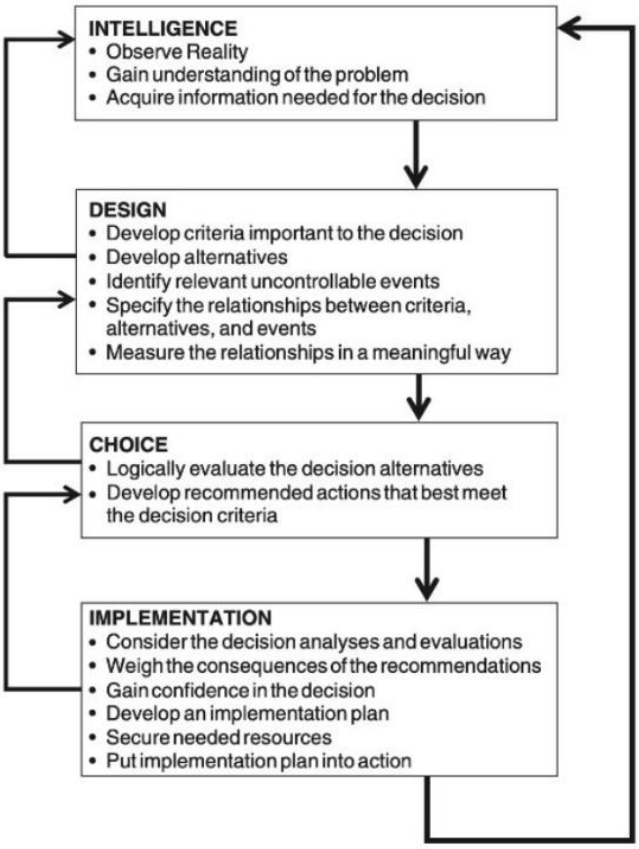

Figure 1: Description of decision-making model from Simon (Doumpos & Grigoroudis, 2013, p.27)

Reviewing decision-making literature (Asemi et al., 2011), a six-step decision-making model emerged based on the initial model from Simon (1997). By following the six-step process the probability is high that an accurate quality decision is concluded (Certo, 1997). Those steps are the core process of decision-making (Asemi et al., 2011). Inevitable for the process is: *1) clarifying the problem* and *defining the solution scenario* at the end. Based on those two parameters, the gap between problem and solution is defined and the *2) gap analysis* can be executed accurately. Thereafter, necessary steps are identified which need to be taken to move from the current situation to the desired future situation. The *3) gathering of facts, options, and alternatives* as well as the *4) analysis of consequences* helps to select a final option. The decision for an effective solution can be implemented based on the *5) best option selected*. After the *implementation*, it is also important to *6) evaluate final outcomes* according to the solution scenario defined. In case no success was achieved, a re-evaluation of the steps starting from the gap analysis phase is necessary. (Uzonwanne, 2016)

Compared to the four-phase model presented above, the first step is covered by the intelligence phase. Steps two and three are included in the design phase and four and five in the choice phase. The implementation phase entails the last step. The six-step model was briefly explained above in order to have concrete points to follow during the analysis of the real estate company's decision-making process. Also, it is more straightforward and can be compared more easily to the decision-making process of real estate companies than the four-phase model.

2.2. Artificial Intelligence

2.2.1. Definition and Classification

There is no universal definition of Artificial Intelligence (AI). “Artificial” entails the human mind creating the “intelligence” (Eber, 2020). In simpler terms, AI is trying to make machines do something, which people currently do better (Holland, 1992). According to a business context, Merriam-Webster’s full definition of AI is *1) “a branch of computer science dealing with the simulation of intelligent behaviour in computers”* and *2) “the capability of a machine to imitate intelligent human behaviour”* (Merriam Webster, 2021). This implies that tasks are performed by computer systems trying to resemble human intelligence (Britannica, 2021). Examples of tasks requiring human intelligence are visual perception, speech recognition, decision-making, and translation between languages (Lexico Oxford English Dictionary, 2021).

Further, AI can be classified into two main objectives. The first one is *strong AI* or human-like intelligence. In this AI objective, systems can think and act like humans or even surpass human beings and make their own decisions and rules to follow. However, this is not currently possible. The second one is *weak AI* or rule-based decision-making. It can be any activity of systems that have been performed by humans in the past. The machines work without human reasoning and take over specific tasks and decisions. Some examples are image recognition, natural language processing, product recommendations, and spam filtering. (Collins et al., 2021) Several business leaders adopt AI development in line with weak AI, using AI as a guide to creating better products or services, rather than trying to create a replica of the human mind (Marr, 2018b).

Another way to classify AI is based on its functionalities. *Reactive AI* is the most basic type, as it has no past memory and cannot use past experiences for future decisions. It only responds to different stimuli. An example would be a computer system that plays chess. In contrast, *limited memory* uses past information and observations for future actions. Deep learning algorithms made limited memory possible. An example is self-driving car decision-making functions. *Theory of mind* is still a work in progress and will be able to interact socially by understanding people's emotions, thoughts, beliefs, and expectations. The final type is s*elf-awareness*, where AI has its own consciousness, or in simple terms, is a complete human being. That means it will not only understand humans but have its own needs, emotions, and desires. However, this stage only exists hypothetically. (Joshi, 2019)

2.2.2. AI Applications for Decision Making

AI has a vast scope of functions. Figure 2 below shows the range of applications AI manages to perform. Usually, the main AI analytics tools integrated into business are machine learning (ML) algorithms that are used to analyze small or large data for the decision-making process (Ajah & Nweke, 2019). Therefore, in the following section machine learning in general as well as the most important machine learning algorithms and tools from a business decision-making perspective will be discussed.

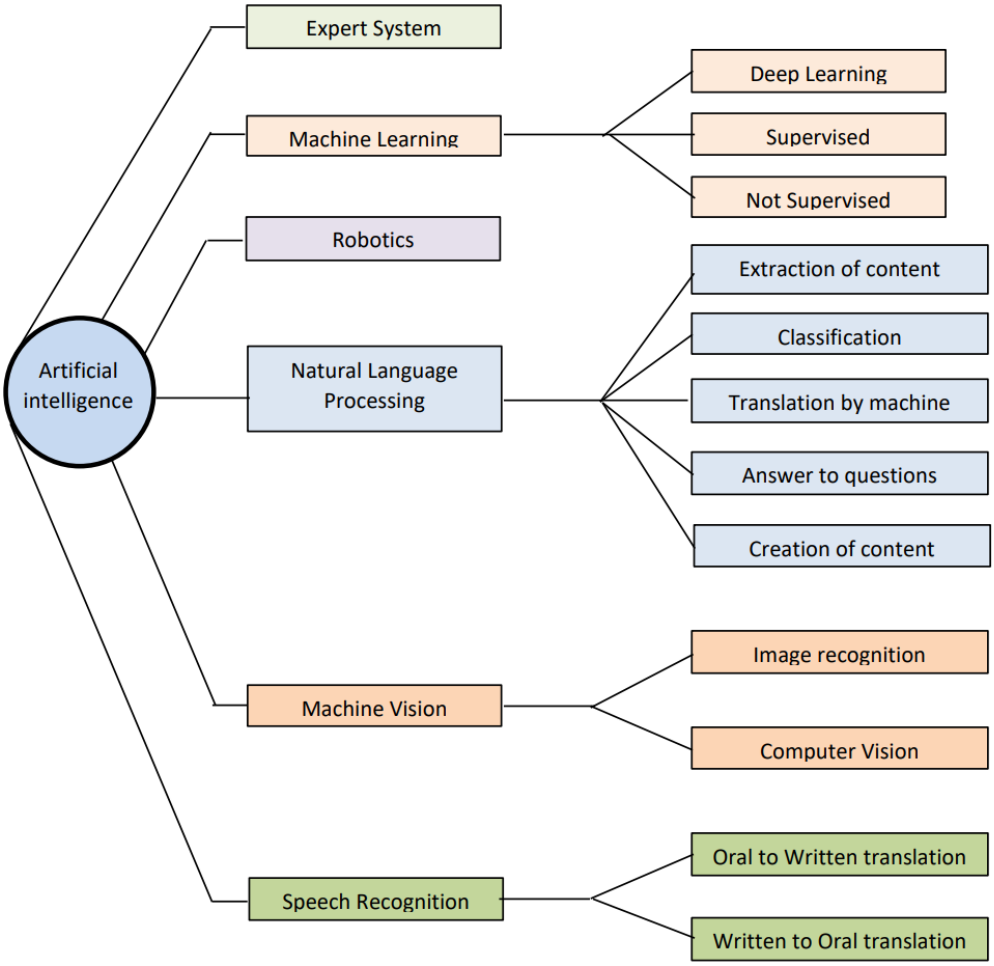

Figure 2: AI Applications and techniques (Dejoux & Léon, 2018, p.188)

In 1959, ML was defined by Arthur Samuel as a branch of science that allows computers to learn without being explicitly programmed (Samuel, 1959). More recently, ML has been defined as the process of enabling machines to get the best possible outcome while performing a task by learning from previous experiences (Ghatak, 2017). AI is at the fundamental level of ML, as it enables computers to learn and think on their own. ML models' main aims are to make predictions via computers and rate models, frameworks, and applications at a statistical level. Real-world problems have high complexity beyond human capabilities and ML manages to help deal with them by being able to analyze complex and large data sets like weather forecasts, web search, etc. (Alzubi et al., 2018)

ML can be classified into three main categories: Supervised learning, unsupervised learning, and reinforced learning (Zhang & Lu, 2021). *Supervised learning*, also known as learning from examples, is a method where machines are provided with correct training outputs that are

compared to those sets that are given as input. The model has guidance and learns from a dataset that is labelled. This can be divided into two different types. First, classification, where data is systematically distributed into categories according to specific features by the machine. Second, regression, where output labels are continuous, which means other features of the data are predicted based on some available features. (Çelik, 2018) Supervised learning is used for text classification in the e-commerce industry, for example. There, the sentiment of a text is predicted to support companies detect negative comments of customers. (Ajah & Nweke, 2019) The difference between *unsupervised learning* and supervised learning is that for the unsupervised approach the output data is not given and there is no labelled training data. The learning process consists of finding the unidentified existing structure in unlabelled data and then concluding rules from it. (Çelik, 2018) Within this process, we can separate clustering, where findings of data groupings are split into smaller groups with similarities, and association, where statistically relevant relationships of variables of big data sets are picked out. An example of unsupervised learning is creating customer segments for targeted marketing. (Ajah & Nweke, 2019)

During *reinforcement learning*, the algorithm is provided with responses telling whether the output is correct or incorrect. To get the correct output, the algorithm has to interact with its environment, rule out and explore several different possibilities to find the shortest way to reach the end goal. In other words, a machine performs actions and uses a trial-and-error method to learn. (Alzubi et al., 2018) The algorithms learn by getting positive rewards for the right ways and negative rewards for the wrong ways (Çelik, 2018). A real-life example of RL is self-driving cars (Alzubi et al., 2018). The difference between reinforcement learning and supervised learning is that reinforcement learning is sequentially working on reaching decisions, the decisions are dependent, and it interacts with the environment. Whereas with supervised learning, the decision is made at the beginning, decisions are independent of each other, and the input is given. (Ghatak, 2017)

In *deep learning*, all three types of learning are covered (Skansi, 2018). If ML can learn 1,000 models, deep learning can learn 10,000. This is because deep learning uses multi-layered neural networks on large amounts of data, which gives it a larger viable space. (Ghatak, 2017) Deep learning and reinforcement learning are both systems that learn autonomously. The difference between them is that deep learning is learning from a training set and applying the learned skills to a new set, while reinforcement learning is adjusting based on feedback to get positive

rewards. (Marr, 2018a) Examples of deep learning are collaborative filtering and neural language translation (Jordan & Mitchell, 2015).

Many other technologies also do repeated work, however, what distinguishes them from AI is that they do not think independently. In contrast, ML has the ability to learn and adapt strategies as well as recognize patterns. Data scientists are trying to create general-purpose learning algorithm to help machines employ more than one specific task. (Verma et al., 2021)

2.2.3. Decision Factors for AI Technology Implementation

AI is still in the introductory phase regarding the implementation and adoption in company processes. Factors that companies are considering when choosing whether to use AI or not are the usefulness of the technology and the difficulty of use. (Kumar & Kalse, 2021) Further factors influencing companies when deciding to implement an AI tool are the expected performance (will it improve the overall performance of the company), the expected effort (how much time does it take to implement the tool), simplification (will it facilitate current conditions) and social influence (will it have an impact on the well-being of employees as they will have more time for other tasks and also improve productivity; Sohn & Kwon, 2020).

A widely discussed theory that may help understand AI adoption is the diffusion of innovation theory. It includes five stages from implementation until adoption: relative advantage from adopting the new tool, compatibility of the tool, the complexity of usage of the tool, trialability, and observability. For the relative advantage, the time saving of the working time of the human has to be compared with the costs, etc. As for the compatibility, it is important to check how much effort it takes to integrate AI with the existing system and how will it affect the current operation. Another challenge in adoption is the complexity of usage if employees require more training and skill to adapt to the technology and how much time and effort the extra training takes. The adoption is not an easy process, as it takes a lot of effort to connect the new technology to existing systems. However, studies report that businesses will have long-term benefits with the use of AI (Kumar & Kalse, 2021) and that AI will play a more central role in a company in the future (Sutton & Sharma, 2021).

2.2.4. Decision Support Systems (DSS)

Decision Support Systems (DSS) can be defined as tools that help in the decision-making process in organizations (Alyoubi, 2015) and are used as a knowledge source to offer several different sources to the decision-maker (Courtney, 2001), who is a crucial part of the system (Phillips-Wren, 2012). Thus, DSS helps the decision-maker to take more knowledgeable strategic decisions (Alyoubi, 2015). Moreover, DSS have been successfully used at the strategic planning levels in companies. There, problems are more difficult to solve due to a large number of factors involved. Globalization will make strategic planning even more difficult, as corporate settings change more quickly due to the internet. (Courtney, 2001)

Figure 3 shows the decision-making process of a DSS. The process starts with recognizing and defining the problem, followed by generating alternatives. With the development of a model, the best option can be chosen and implemented.

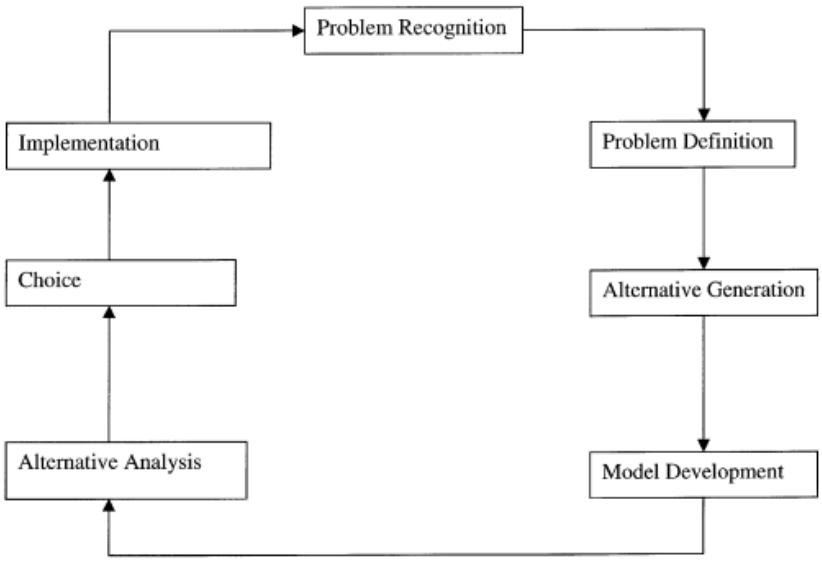

Figure 3: DSS in the decision-making process (Courtney, 2001, p.19)

Intelligent Decision Support Systems (IDSS) add AI functions to DSS to be able to provide the user with new capabilities. Numerous examples have been provided by literature showing that IDSS improves outcomes of the decision-making process. IDSS support decisions successfully as they help to perform the task, process data and information to produce knowledge, and learn from experience. In management situations, IDSS help to improve the decision accuracy and express preferences, for example by bringing resources together and offering capabilities that support the decision-maker. AI tools not only improve the outcome, but also affect the

decision-making process itself as they can provide real-time responses, personalized information, several different sources, automation, and present reasoning patterns on which the decision is based. (Phillips-Wren et al., 2009)

2.2.5. AI and Humans in Decision-Making

Around 50-75 years ago the main processor of business decision-making was human judgement, which is mainly characterized by instinct and experience (Colson, 2019). However, human capacity to process data is limited (Trunk et al., 2020). Also, judgement is impaired as the human brain is exposed to several cognitive biases. Due to these biases, our decision-making differs from rational objectivity. To counteract this, the "data-driven" approach is applied, in which data is pre-processed by machines and then further used as a base for decisions by humans. As humans still make the final decision, not all information is used effectively, and cognitive biases do still not disappear. Accordingly, it makes sense to delegate decisions that solely rely on structured data to AI. This "AI-driven" approach is more consistent and objective in making decisions and better leverages the data. However, some business decisions are based on more than just structured data and some additional information is only available to humans, like values, strategies, and culture. (Colson, 2019) In these situations, humans can choose the best alternative as they have access to their experience and personal judgement (Jarrahi, 2018).

Different scenarios of execution depending on the situation can be applied to the decision-making process combining humans and AI. Sometimes the AI tool analyzes the data to make the final decision for the human easier. Other times, human judgement is used as input for the AI system to process and AI makes the decision autonomously. Another option is an iteration between humans and AI processing. AI offers the advantage of dealing with complexity and spotting trends faster, whereas humans are good at making more creative decisions and additionally considering external factors. As a result, in most cases, leveraging both humans and AI in the decision-making process is the most successful. Having humans not interacting directly with the data, but rather with the data pre-processed by AI systems can result in many new possibilities. (Colson, 2019) For several businesses it is hard to take full advantage of AI systems as 64% of decision-makers state that the team does not understand or trust AI recommendations (Bothun et al., 2017). Therefore, it is important to have leaders who can integrate relevant technologies in their organizations in a smart way (Snow et al., 2017).

2.3. The Real-Estate Industry

The Real Estate Industry is globally growing enormously in recent years and has attracted immense financial investment (Ullah et al., 2018). For some years now, prices for houses and apartments have been rising in many countries, in some cases considerably (Kholodilin & Michelsen, 2019). One of the main factors for the price increase is the growing demand for housing options due to population growth. However, another major reason is the demand for capital investments. (Kuang et al., 2020) These investments influence the employment rate of a country as well as the gross domestic product (Breuer & Nadler, 2012). Therefore, more and more real estate projects are being developed to meet the demand of the population (Spars & Guhl, 2021). In contrast, the real estate decisions for these projects are becoming more complex and difficult to determine, as various new regulations have to be followed, the current market situation has to be evaluated, advanced technologies have to be included, etc. (Kuang et al., 2020). What makes it even harder to address these factors is that especially the construction industry is more resistant to change regarding digitalization compared to other industries in the world. It is difficult to adopt and modify processes when real estate companies are working on projects that take more than a decade to complete. This gives them more time to adjust to current developments, which is why there is no rush to implement AI. The lack of digitalization makes projects unnecessarily challenging and leads to cost inefficiencies, uninformed decision-making, and delays. To overcome the challenges, it is necessary to rapidly improve technologies. The reasons why real estate companies still struggle with the adoption of AI might be cultural barriers, the trust in AI technologies, and the high initial cost of implementing AI tools. Thus, a study has shown that AI has already helped to achieve contributions to improvement in recent years. (Abioye et al., 2021)

The rising interest in investing in real estate products and the complexity of large projects and decisions makes the sector very interesting for research. As several different divisions within a real estate company play a role to reach a final decision, it will be helpful to have a closer look into their decision-making processes and learn about their currently used systems and technologies.

2.3.1. Real Estate Decision-Making

Real estate decisions are not a single act, instead, they are a time-consuming and effortful process with various necessary steps. Throughout the process, it is important to use accurate

and current information. Moreover, the decisions of each step are commonly impacted by the data established in the previous steps. (Kohlhepp, 1997) Results of an investigation show that the basic steps of the decision-making process in real estate companies have not evolved a lot since 1996 (Farragher & Savage, 2008). Real estate development is a process that involves several phases. First, the land is purchased, followed by the construction, renovation, or maintenance of a building and eventually selling or leasing the finished product to end-users. (Peiser, 2015)

The decision-making process of real estate investors is based on limited financial considerations (Chaillou et al., 2017). Interviews conducted by Chaillou and collaborators with real estate fund managers confirmed that, as there are three main points managers look out for. Firstly, the purchase of land which needs to be cheap or at least affordable. Then, the signing of leasing contracts and lastly, the optimal structure for the project. The mitigation of the development risk throughout the asset portfolio diversification is another part of the decision-making process that is taken into consideration. A former CEO of a leading real estate development company stated that, when dealing with large and risky investments, real estate companies would commission market research to verify their assumed demand. Still, urban analytics, like for example the distance to public transport options, were ignored and no structured forecast was conducted. (Chaillou et al., 2017)

Because several different areas of a company are examined during this work and decision-making processes can vary slightly depending on the department and the underlying project, no decision-making process is presented as a general example in this chapter. The explicit stages of the decision-making processes will only be discussed in the results section, taking into consideration the input of the interviews.

2.3.2. AI in Real Estate Decision-Making

AI is currently implemented in several industries and is also used in the real estate industry for business applications (Ullah et al., 2018). Especially real estate projects become more extensive and complex having several stakeholders with different interests. The demands on real estate companies are becoming ever more stringent and a finished construction project is required in the shortest possible time with a relatively tight budget. Construction management is supposed to deal with these issues very precisely. The human mind is pushed to its limits by the size and complexity of all the data that needs to be processed. (Eber, 2020) The key to better decision-

making can be the collection of larger amounts of data that needs to be organized and analyzed to use its power (Eber & Zimmermann, 2018). AI is used to support and simplify the data provided. The most effective solution companies are working on is combining AI and human intelligence to still make use of human qualities that AI cannot provide, like creativity for new ideas and the ability of prioritization. (Eber, 2020) A scenario for a decision based on an AI tool for a real estate investment could be that the locations of different properties are analyzed and compared. The prices are calculated considering the distance to the next subway station, for example, and several other factors. According to the outcomes, the decision is made by the human, and the company might be willing to buy the chosen property for a higher price as the location is more appropriate for the intended conditions. (Chaillou et al., 2017)

There are several other examples where subfields of AI already help in the real estate business, like sales or building decisions based on machine learning tools (Ullah et al., 2018). By using AI software, the data can be visualized, filtered and future market scenarios, financial assets, and other decisions can be simulated. This way the company can assess market trends and predict future outcomes. (Chaillou et al., 2017) The main AI applications used are machine learning, which includes deep learning, neural language processing, and automated planning and scheduling. ML has been utilized for a variety of purposes, including risk prediction, safety monitoring, cost estimation, supply chain and logistics process improvements. Robotics has been used in building materials, plant, and equipment management, as well as site monitoring and performance evaluation. Risk and waste management, conflict resolution, sustainability evaluations, and other tasks have all benefited from knowledge-based systems. They were part of the disruption of the real estate industry, as the new algorithms have led to improvements regarding cost-efficiency, compliance with deadlines, and reaching certain other goals. (Abioye et al., 2021) A metric that can follow valuations of various properties in a country is already widely accepted by real estate professionals. Still, predictive analytics has a long way to go in the real estate industry. Currently, there are mainly predictions one year from now. However, the tools could be able to predict outcomes for the next five years. Therefore, forecasting future scenarios might become common practice in the next decades, also, because the ability to forecast increases and the cost of efforts decreases due to new technologies, like AI. (Chaillou et al., 2017)

3. Research Methodology

3.1. Research Approach and Setting

The aim of this work is to analyze how AI is impacting the decision-making process in various departments of a real estate company. In particular, the AI tools currently used for decisions in the real estate industry and their impact on the process are explored. As this topic has not yet been discussed in academic literature, an exploratory research design was used (Birkinshaw et al., 2011) to seek insights into the general nature of the topic and gain background information (Thomas & Lawal, 2020). The application of a qualitative research method is the most suitable since the research subject is approached as openly and flexibly as possible during the data collection to discover meaningful information about the respective topic (Zepke, 2016).

3.2. Data Collection

Secondary data, which is data that has already been gathered in the past, was collected to help design the primary data collection process. Mainly journals, but also books, websites reports, etc. were used to gain an overview of the decision-making process in general, AI, and the real estate industry (Johnston, 2017). Also, the decision-making process in the real estate industry and the currently implemented AI tools in real estate companies were presented in the literature review.

Complementary, to answer the research questions, primary research was conducted (Baker, 2020). In-depth interviews (Rynes & Gephart, 2004) were carried out between the period of October 2021 up until December 2021 with a total of 10 interview partners. Aiming to discover detailed information and a greater understanding of the topic, semi-structured interviews were conducted (Arthur et al., 2012) with employees working at a real estate company. The participants are key informants, who are involved in the decision-making process of real estate decisions in different departments. The interviewees were contacted through a contact person at a company and appointments were made via email. Then, the interviews were held via online calls and lasted around 30 minutes to one hour. With some participants the interview was held in German, whereas other answered the questions in English, depending on the interviewee's preferences.

Since there are numerous steps in the decision-making process, just a few were chosen for a more extensive explanation and study. The construction process, which is the main business of

a real estate company, was thoroughly examined, as were other processes that play an essential part in real estate growth, such as Real Estate Investment, Business Development, Risk Management, and so on. It is possible to gain an insight into the similarities and variances in the decision-making processes across the chosen departments. Furthermore, the extent to which AI is currently implemented in one department, rather than the other, should be investigated. Table 1 gives an overview of the conducted interviews.

Type of Data	Area of Expertise	Position in the Company	Date of the Interview	Interview Length	Use of AI
Interview 1	Real Estate Investment	Department Head	08.11.2021	27:55	No
Interview 2	Construction Contracting	Department Head	16.11.2021	35:52	No
Interview 3	Architecture	Architect	16.11.2021	35:52	No
Interview 4	Project Management	Team Leader	16.11.2021	1:03:33	Yes
Interview 5	IT security	Department Head	17.11.2021	42:08	Yes
Interview 6	Facility Management	Division Manager	19.11.2021	31:56	Yes
Interview 7	Construction Management	Division Manager	24.11.2021	56:28	Yes
Interview 8	Risk Management	Department Head	29.11.2021	32:15	No
Interview 9	Business Development	Department Head	01.12.2021	28:16	No
Interview 10	Real Estate Investment	Department Head	10.12.2021	33:34	No

Table 1: Overview of Interviews

The interview guide was sufficiently structured to be able to address the most important topics that need to be discussed, however, this structure enables the participants to still touch new subjects. The questions are arranged in segments to ensure that all necessary topics are covered. The questions vary from full open-ended questions to more theoretical questions, which is appropriate for the complexity of the research topic. Since the interviewee is engaged, the reciprocity between the researcher and participant makes clarification and a critical reflection possible. (Galletta, 2013)

At the beginning of the interview, general information about the dissertation is provided and the procedure is clarified. The interview starts with a brief introduction, followed by asking for the recording consent and informing the participant of the confidential data handling. The anonymization of the company, including the interviewees, is guaranteed. The first part of the interview includes an introduction of the company the interviewee works for as well as a short description of his/her position given by the interviewee. The next part gives some insights into the real estate industry in general. Afterwards, key questions are asked, and the main discussion will take place. In the end, trends and outlooks are examined, and afterwards, for the conclusion, the final comments of the respondents are discussed (see Appendix 1 for the interview guide).

3.3. Data Analysis

For the data analysis, the thematic analysis method is used. It is widely applied and offers a flexible and effective approach for qualitative data analysis (Braun & Clarke, 2008). Thematic analysis is a method for organizing, identifying, and describing insightful findings within a data set (Nowell et al., 2017). The freedom of this method enables the researcher to create value by summarizing key insights of a complex and considerable data set (Braun & Clarke, 2008). Since a structured approach is taken, one organized and clean message can be reached (Nowell et al., 2017).

After the interviews were held, the voice recordings were transcribed and reviewed again accurately to get familiar with the data. Notes of essential information were taken, focusing on statements made by the participants. To create a clearer overview, codes of patterns or relevant information are generated. The codes were then collated into potential themes, which represent something important about the data that is related to the research question. Finally, the report was produced, stating examples, relating to the literature review, and answering the research questions. (Braun & Clarke, 2008) Due to certain facts mentioned during the interviews, some data is given in a coded form to assure anonymity. The information was coded in case company-specific information is given identifying the firm. This includes, for example, the company name or operational departments, which will be coded as *company* or *department.* The interview transcripts are not available in the appendix at the request of the company. Thus, an overview of the main findings can be found in the appendix (Appendix 3).

4. Results

In this chapter, the results of the interviews are presented and analyzed. By carefully checking the input provided by the participants, themes were created to structure the information given. First, in chapter 4.1. the structure of the decision-making process in a real estate company is presented (which addresses RQ1), followed by the challenges of the decision-making process in chapter 4.2. (which answers RQ2). The use of AI, which is discussed in chapter 4.3., includes the current implementation (which addresses RQ3), the opportunities and challenges (RQ4 & RQ5), autonomous decision-making (RQ6), and future trends.

Categories – Initial Topics	**Themes evolved - Structured Chapters**	**Research Questions addressed**
- Structure of decision-making process	4.1. Structure of the Decision-Making Process in a Real Estate Company	RQ1
- Internal decision-making challenges	4.2. Challenges in the Decision-Making Process in a Real Estate Company	RQ2
- Usage of AI tools	4.3. Use of AI in the Decision-Making Process	
- Implementation Factors and Challenges	4.3.1. Decision Factors for AI Technology Implementation	
- Current Implementation Areas	4.3.2. Current Implementation of AI	RQ3
- Opportunities Using AI - Challenges Using AI	4.3.3. Challenges and Opportunities	RQ4 & RQ5
- Human and AI - Autonomous decision-making	4.3.4. Autonomous Decision-Making Using AI Tools	RQ6
- Trends and Outlook	4.3.5. Outlook and Future Trends	

Table 2: Overview Grouping of Codes

The following presented results are based entirely on the participants' remarks and findings during the interviews. Therefore, the statements in the following sections are not generalizable. Mainly only generic reference is made to the interview partner to ensure the protection of anonymity.

4.1. Structure of the Decision-Making Process in a Real Estate Company

Various areas with individual decision-making processes were identified during the interviews in a real estate company. According to the participants, a finished property goes through several phases, starting with the purchase of a property, then the construction process, which is the core business, and/or the maintenance process, and ending with the sale. At the beginning of every decision and project stands the idea and the strategic need for it, which is included into the target portfolio. The target portfolio is defined by different factors, such as demand, return requirements, and the consideration of future developments. A participant mentioned that "there is a gap between the portfolio in its current form and the target portfolio, which the investment strategy tries to close." Different options can be consulted in order to close the gap. One of them is the investment in or acquisition of new real estate.

By further discussing the acquisition process in detail during Interview 10, it has become clear that the process includes a screening phase with market research, a technical screening, etc. from which a business case develops. After the executive board approves the business case, the due diligence phase starts, where the opportunity is examined, followed by a cost-benefit or investment analysis, an economic audit is conducted, and the transaction is performed. For the construction process of the interviewed company, five phases were identified – acquisition, preparation, planning, implementation, and closing. One of the participants stated, that after the acquisition, and to start the project, a framework is defined, and the financial, organizational, and practical feasibility has to be proven. The profile of requirements is discussed and studied to check if all the requirements are convertible. During the preparation process, the project manager looks for suitable planers and partners, calculates expenses, and the planning agreement is signed. As soon as the release from the user is made by signing the planning agreement, where the costs and the risk are transferred to the user, the project goes into the planning phase. There, one interviewee mentioned the preliminary draft which is reviewed and improved with rework loops to find alternative solutions in case the one presented is not satisfactory. According to statements of the interview partners, the final draft is released, and afterwards the building permit procedure is initiated. Then, the detailed planning starts, as one of the participants further explained. By further deepening the plan again, new questions arise. In the best-case scenario, previous planning is flexible, allowing modifications to be applied quickly. Flexibility also saves costs if adjustments can be made later without causing major issues. The calls for tenders for the construction work take place and the construction starts. On-site, the construction supervisor is responsible for the order and coordination of the

tasks. One interviewee emphasized that “during the construction, close coordination between the commissioning company, the building company, and other partners is required.” After the construction is finished, there is a preliminary settlement. In addition, a construction defect procedure is performed prior to the handover and the final inspection takes place after the completion of the object. According to the participants, a project can take up to ten years to complete. In the meantime, loops are used by the project team to try to incorporate modifications and alterations of the basic requirements into the project plan. This is merely a general summary of the procedure because it is far too complex and lengthy to discuss all of the specifics. It was mentioned by several participants that aside from the construction process, the purchased site may include a structure that needs to be renovated or maintained. For that, the real estate company has a role called facility management. Experts of the company working in facility management will guarantee that a building is well-maintained and that a property is well-cultivated.

Apart from the real estate company’s core business – the construction process – the participants talked about different supportive processes. Risk management for example is responsible for the analysis, assessment, identification, and aggregation of risks, and identifying risk-minimizing measures. The participant mentioned that “risk management also implies quality assurance, which has a strong interface to different areas in the company.” The decision itself is not made by the manager of the risk department. However, the latter prepares the risk and opportunity outlines and derived information as best as possible as preparation for the decisions. During another interview the Information Technology (IT) department was discussed, and the participant explained that it provides technical support for the company. In addition, the IT security professionals working in the department keep an eye on network and application performance to spot any unusual activities. Security practices are audited regularly to verify compliance in the interviewed company. Business Development is responsible for everything that is not covered in line-functions and the classic standard real estate business. According to one of the participants, it includes new ideas, strategic new business areas, purchases, and investments of non-real estate related topics that are, however, supportive for the company and their core business. Other departments, such as Human Resources and Marketing, were not included in the interviews in order to focus mainly on the core business of a real estate company.

4.2. Challenges in the Decision-Making Processes of a Real Estate Company

The interviews provided information about the various challenges of a real estate company's decision-making processes. One of them that was mentioned by several participants, is the large amount of data that needs to be handled for the projects. Another interviewee talked about the general situation on the real estate market, which is also a major difficulty, as the scarcity of market data and transaction data makes the process non-transparent. To coordinate and synchronize demand is challenging as well, as it takes time to react to the demand can only be met a few years later, according to the participant. As a result, it is critical to include future developments and changes into real estate investment decisions. It was also mentioned during an interview, that at the beginning it is essential to find the right opportunities that fit the target portfolio. It was further explained that the problem is that the competition is huge and there are comparatively few good products. With so many technology providers on the market, choosing the right one is complicated and time-consuming. Also, the interviewee stated that complying with deadlines, legal requirements, costs, and quality standards can be challenging. To ensure a seamless process, it is critical to have a clear understanding of the framework conditions from the beginning of the project. One of the participants emphasized that investing sufficient time prior to the project's start to understand what is desired and to ensure that the requirements are clearly formulated and defined is very important. The better the framework is specified, the better the results will be, and planners will have no room to interpret things different than intended. The majority of the participant agrees that during the whole process, security measures are a very important factor. There, the balance of cost, resources, budget, and prioritization are the main challenges mentioned.

Another challenge in the decision-making process of the researched real estate company is organizational measures, where various departments have to work together to achieve the end goal of a project. There is the project team, an external planer, technicians, and various other people who are involved. Many participants agree that especially at the beginning of the project, it is important to build a good project culture. The project manager is trying to select the most qualified and motivated individuals feasibly. He must also ensure that they understand and adhere to the project's goal, as well as that they have the necessary tools to do so. To make things easier, the project manager might establish guidelines to ensure that everything runs smoothly. Even after considering all these factors, there may be further issues that are neglected. One of the participants stated, "you can do things poorly, but it is even worse not to do them at all." This can be avoided by effective communication. Communication is crucial,

according to the majority of participants, and it can help to reduce the risk of making mistakes. Another key responsibility, according to the project manager, is to ensure that meetings are held at regular intervals. This also helps to avoid unpleasant surprises like large cost overruns. Furthermore, one of the interviewees emphasized that resource consistency is essential. Real estate projects can last up to a decade, or even longer in some situations. One of the participants mentioned that it is not unreasonable to expect a project to take six years to be completed. If personnel must be changed regularly during that time, knowledge will be lost during the transfer. As a result, the company focuses on sharing and documenting everything properly.

Whereas the challenges mentioned above are more general and could apply to any project in any industry, the next points are mainly real estate related. During the planning phase, one of the participants mentioned that "the challenge is to harmonize and coordinate planning activities." It was further explained that it is critical to make early decisions in a collaborative manner and to recognize mistakes at an early stage. Hence, collision points must be found and avoided at the planning phase rather than on the construction site, because there are so many different planers and craftsmen working on the same project at the same time. Machine maintenance is another crucial aspect of the real estate market, according to one interviewee. Some examples mentioned were a new building where machines must be chosen, installed, and fitted together or an old facility where equipment must be examined. The participant further explained that "before AI was used, 30 to 40 sample machines were randomly chosen and thoroughly inspected by an employee." It took a lot of time and effort and, as only a random sample was selected, there was a great probability that defective objects were missed.

4.3. Use of AI in the Decision-Making Process

4.3.1. Decision Factors for AI Technology Implementation

All the AI tools that are currently tested and implemented by the interviewed company are based on purely strategic investments. The participant mentioned that "the process starts with the problem that occurs and the identification of the company's pain points by the different departments themselves." A market solution is then sought by the business development sector of the researched real estate company. It was also stated during the interviews that, as a result of digitalization, technological advancements are currently being implemented to improve operations and increase professionalization. Deciding on software is mainly a one-time event and it is too costly to test several different ones, according to one of the interviewees. Still, it

has to be ensured that the software fits the portfolio. It has been stated multiple times by the key informants that AI is not employed solely for the purpose of claiming to be employing an AI tool. In most cases, the software is tested on several pilot projects characterized by varying requirements. The decision-making process is seen as complex with many factors to consider. When deciding to invest in an AI tool or not, the accuracy and speed of the tool, the errors it makes, the cost, and the effort and time of reworking are considered by the interviewed company. Because real estate projects typically have significant lead times, testing the software and deciding on the best fit takes time. As for the implementation, the challenge the real estate company faces is to connect the interfaces of the AI and the company's own system. It is necessary to ensure that software and company processes are both technically and cooperatively compatible. Another factor that was referred to by several participants is that data volume is a challenge when implementing the AI tool. The issue is how the system accesses the data and how the data is transferred. Data security, as well as how quickly and successfully the system learns, are important considerations that were mentioned.

4.3.2. Current Implementation of AI

The participants of the interviews talked about certain AI tools that are already tested or implemented in the various processes of the company. The following section will present the AI tools used and their functions.

Currently, in the construction process, more specifically the project management department, an externally developed AI system is tested that should help identify risks early on during a project, like one of the participants (Interview 4) explained. It was mentioned that sometimes project managers go headfirst into a difficult scenario, believing that everything will work out, only to be confronted with a crisis. The ideal scenario would be to notice the problem early on and intervene before it became a crisis. So, the AI 'early warning' system analyzes unstructured data that is generated during a project, like emails, documents, plans, protocols, etc. The system recognizes building-specific annotations such as costs, deadlines, emotions, quality, etc., which are then rated, clustered, and mapped in accordance with supervised learning. The participant further explained that "the terms are grouped according to their emotions, and the tasks are better ordered. The essential documents and data sets are displayed and available for project managers to analyze using a simple navigation." The participant talked about the example that emails are organized according to their urgency and within the email, negative facts are

displayed in red whereas positive facts are displayed in green. According to the interviewee, the added value can range from the avoidance of additional costs to an increase in project stability and greater satisfaction of all project participants. With the support of the algorithms, the risk manager or the project manager can concentrate on the value-adding tasks and his core competencies. The operational areas of the AI system in the researched company are risk management, conflict management, and support of the knowledge transfer in different hierarchy levels. The AI tool accompanies the process right from the beginning of the project, like one of the participants stated.

In the case of building maintenance, the participant in Interview 6 talked about an AI tool that is currently being tested for data management and data quality assurance. According to his/her experience, real estate initiatives must deal with a large volume of data, which can be extremely beneficial if managed correctly. Hence, an AI tool was implemented to check the plausibility of the available data accordingly and systems have been built up so that this information can be received automatically. An example that was provided by the interviewee, is the energy management of maintained machines in a building that has to adhere to certain testing intervals. AI ensures that the necessary tests are carried out, using supervised learning. The data of the machines was systematically recorded in the past. Currently, it is checked by a human whether the recording is correct, and the AI finds out where implausible values exist so these can be corrected. Also, the participant mentioned that "AI systems independently try to make connections based on the collected information (what kind of house is it, what area and equipment) and then show where connections fit and where something is wrong. The AI tool signals if a system does not fit with another and then the system is replaced by humans." During the Interview 9 with the Business Development department the idea behind the implementation of the AI tool, which serves as an IDSS, was explained, which was in that case the decarbonization of the portfolio's CO2 footprint and the question was how properties can be decarbonized. The participant further stated that the energy optimization software gets data of users, knows how the users move inside the properties, based on detection and historical data, weather data and external influences are added that affect how much heat and electricity is needed in the properties. The AI behind it continuously delivers data points every 15 minutes and calculates how to distribute energy most efficiently in the building. The goal is to work with as much CO2-neutral generated electricity as possible and optimize the process.

During Interview 5, another AI system, which is currently being tested for electronic invoices, was described. There, the goal is that the invoice is sent to a server address, where it is analyzed

and re-formatted and automatically sent to the responsible department or person. The example used by the participant was that, in case the invoice is sent by post, it is scanned by the responsible person and the AI tool does the rest. Before, the person had to open it, check the data, and distribute the paper format. With AI, the invoice is automatically received, processed, and included in the system.

Concerning the planning phase, no AI tool is yet used according to the participants in Interview 2 and 3. However, a 3D model is applied, where collisions (for example the crossing of cables) are recognized based on rules and standards which are depicted in the model. The model detects errors, and the evaluation is up to the human being. Not every error that occurs really is an error. The person responsible can then judge and accept and change or reject and keep it. According to an interview participant, planning is a creative and individual work with different tasks and prerequisites each time, which should not be stifled by algorithms or systems.

During Interview 8 with the department head of the risk management department, the participant mentioned that no AI tool is deployed. However, AI is utilized to help identify dangers at an early stage of a project during the construction process, as seen above. The majority of decisions in risk management are made only once, according to the head of the department. Therefore, from the participant's perspective, it is not feasible to apply AI at the moment. Thus, simulation software is used that represents static data dynamically and quantitatively, as behind every opportunity and risk stands a range of possible expressions how the situation might turn out. The participant explained that distributions are calculated within the software with parameters that are subject to uncertainties.

4.3.3. Challenges and Opportunities

During the following section the challenges and opportunities of each AI tool or software currently used is examined and explained in detail, as the interviewees mostly talked about challenges and opportunities related to the concrete AI systems they used.

According to one participant, by utilizing AI, the early warning system allows for the identification of problems and the avoidance of a crisis. It was mentioned by the interviewee that "problematic judgments should not occur since the team is advised what to look out for early on in the process. In addition, the system aids in identifying possible conflict and notifies you whether you have everything under control or whether you need to pay greater attention to

the project." The interviewee further mentioned that the more complex a process is, the more people are involved. As a result, having a tool that assists can be beneficial. In terms of communication, due to the volume and flow of messages and information, a manager cannot read through everything. The tool assists in identifying and highlighting the right and critical points.

In the case of electronic invoices, the participant stated that an AI tool can recognize classic and standardized invoice features quite effectively. When the AI system encounters a lot of repeats and similar patterns, it performs exceptionally well and quickly. The issue is that AI is unable to understand the data when there are exceptions, such as when customers and suppliers provide non-standardized bills. As a result, exceptions must be taken into account. AI systems do not operate without error tolerance, as one participant put it: "Where error tolerance is not permitted and given, AI is not possible and not applicable as of today." The employee used to have to take the invoice and put in the characteristics, but now only the invoices with errors must be examined. Because the invoice is rushed through, the goal in the future is to not fill in any values at all. The majority of participants agree that employees would not be replaced by the AI tool, but their workload would be reduced, and they would be more productive in other tasks that they have to do. Being more efficient also means cutting costs and becoming less expensive, allowing you to offer better prices to the customers. It was mentioned during one interview that it is also more environmentally friendly and sustainable.

According to the statements during the interview with the department head of risk management, using the simulation software (not AI) for risk management results in better chances to assess the risk. It leads to a significant added value as risk and opportunity information is included in an investment decision that was not quantitatively considered before. Within the iterations all possible combinations of possible result scenarios are played through. The result is distributions where worst-case and best-case scenarios are displayed. Thus, the interviewee explained that the software does not work alone. Someone has to say what can happen in the worst case, for example, with the market price, derive risks, and using the software, the image, and the numbers flow in.

A significant exception to the challenges and opportunities related to concrete AI applications was professionalization. The interviews provided information about one of the expected opportunities of AI adoption, which is professionalization. AI is a demanding software that needs data upfront. The portfolio is forced to develop further so that AI can work with it.

Necessary data points need to be delivered, maintained, and mapped systematically to ensure the usability of the software. “This way, the AI tool catapults portfolios of real estate companies digitally much further than they would eventually develop on their own”, as one interviewee stated. Another chance using AI, that many participants consider, is simply to ensure the quality as suggestions for improvement or non-plausible conditions are pointed out. According to the participants, the AI tool unquestionably speeds up the decision-making process. The rapid improvement benefits that happened when the AI technology was introduced were rather startling. The main challenge mentioned is linking external software with the companies’ databases so that it adds value and information is fed back accurately.

4.3.4. Autonomous Decision-Making Using AI Tools

According to the majority of participants, AI systems would support humans and not replace them. In general, the interviewees do not believe that an AI tool can solve problems itself in the building process in the current development state. For many decisions it does not pay off to invest in AI, as humans are also capable of deciding. Currently, in the researched company, the human controls the situation and makes the final decision after AI gives suggestions or draws attention to situations, which saves time. According to the majority of participants, AI can give a basis to be able to make decisions more quickly and to react more quickly. They agree that it is a good and useful method that is able to prepare things so that decisions can happen on a better processed basis and in less time. One participant mentioned that “as far as software is concerned, which permanently monitors all risks and pre-assesses decisions apart from the construction process, it is imaginable that recommendations are made by AI.” It was further explained that with AI making recommendations, resources would be saved, and possible errors could be reduced. However, all of the participants agree that as of the current state of the AI development, it would still be better if the software prepares information, and the project manager then makes the decision. One of the participants explained that depending on the situation, either the human controls or post processes AI outcomes (example of invoices) or he/she must react on them (example of early warning system). The learning curve and trust will hopefully increase with time, according to the statement of one participant, and then controls of humans can go back and AI tools will become more efficient. Another participant mentioned that it rather is the human who tries to prevent AI from getting more control, because they are too afraid that they will be replaced. The interviewee further stated that “in the future

it might still happen (AI getting more control) – the best example is the energy efficient AI tool already used that is more effective than the human."

One participant mentioned that what AI will certainly be able to do is optimizing the control of machines regarding energy savings or efficiency. At some point it no longer needs people there. Also, according to the participants, the AI system has the potential to recognize conflict. However, in their opinion, it will still take years for AI to work on its own, especially in the real estate sector, that is further behind in terms of digitization in general. And to the question about the risk of AI systems making mistakes, one participant encountered that humans make errors as well, the question that arises is, rather, who makes fewer errors. If AI works correctly then the error susceptibility is zero and, with humans, it will always remain the same. Therefore, most of the interviewees agree that in the future there will certainly be an advantage towards AI in some areas in the company.

4.3.5. Outlook and Future Trends

With a few exceptions, the majority of participants expect that, in the future, more processes will be supported by AI. Examples mentioned are that network security - data, traffic, data garbage - are gigantic and hardly any human can sift through them, whereas AI is already very strong in this area. In the security field, the department head stated that the main reason to implement AI in the future is not that you want to replace humans, but rather that work could be done that would otherwise not be possible to be done by humans. In the real estate market, an advantage compared to competitors could arise when using AI. According to the participants, it could help with quality assurance; the project failure rate could be lower, and in the long term, if all projects go smoothly, new customers could be generated because the company has been identified as an expert. Regarding the planning process, it is not expected by the interviewee that AI tools will be applied. As mentioned before by one of the participants, planning is a creative and intellectual process with unique requirements for each project. If a standard, rule-based approach is required, the situation may be different. Then, depending on the standard data that has been used numerous times before, it is possible to use AI as a supplement.

When the interview participants were asked whether they think AI will expand in their company in the future, many mentioned that new technology and digitalization have become indispensable. Some of them further stated that when data becomes even more unmanageable,

even those who refuse to adapt and embrace new tools will see AI as the solution. As data volumes and developments of new technologies grow, AI may be integrated into a risk software. The availability of data and the assurance of data quality are both prerequisites for an AI tool. According to the interviewee, as soon as that happens, the tool might be used for support. However, the human still has to make the final decisions, as it is vital to think outside the box when analyzing opportunities and risks. One participant mentioned that "emotion, as well as logic, play a role in the decision." The example given was that if everyone on the market sells their house because they are afraid, it has an irrational effect on the values, that an AI system cannot yet take into consideration. Therefore, the use of AI only makes sense to some extent. It is critical that key aspects of human nature, such as emotion and anticipation, are preserved, according to the participants.

5. Discussion

5.1. Main Findings and Recommendations

The real estate industry is lagging concerning application of digitalization steps. This is because companies in that sector have a greater consistency and more time to adopt to current developments than other companies in other industries. Especially the construction industry is resistant to change regarding digitalization compared to other industries, which makes it even harder to address currently faced challenges. However, based on the findings of semi-structured interviews with real estate experts, AI can assist in overcoming some of the problems encountered during the decision-making process. These include, for example, the ability to successfully process large amounts of data or the ability to identify risks earlier in a project to avoid a crisis. By examining the influence of the usage of AI on the process, the underlying work reveals that using AI enhances the decision-making process. Currently, AI is tested or used for different processes in different departments. The current state of development of the AI systems allows companies to work with weak AI with limited memory. The main application works with ML, which is used for risk prediction. What they all have in common is that AI enables faster and more effective decision-making, as well as increased efficiency and productivity. The main competitive benefit is that risks can be reduced, and employees have more time for other tasks.

The researched company's investments in AI tools are exclusively based on strategic decisions. AI systems do not replace humans but support them in some steps of the decision-making process. AI functions are currently employed more as a decision support tool than as a decision-making tool. In the future the question will be who is going to bear the responsibility as AI is going to take a more central role. Also, the results indicate that when a real estate company implements AI into their processes, technical and financial challenges are faced. Another factor to consider while adopting AI is the availability of sufficient data for the system to process. It is also critical that the system fits the company's portfolio and is thoroughly tested prior to adoption.

Regarding the decision-making process of the researched real estate company, similarities to the presented six-step model in the literature review were drawn. The need for the project at the beginning of the process and then the acquisition of property represents the first step – *clarifying the problem and defining the solution scenario* – of the six-step decision-making process presented in chapter 2.1. Step two – *gap analysis* – can be compared to the cost-benefit or investment analysis, whereas the preparation process and the choosing of the right and best partners is covered by steps three and four – *the gathering of facts, options, and alternatives and analysis of the consequences.* After *the best option is selected* (step five), the planning starts, followed by the implementation, and the closing, after which the *final outcomes are evaluated* (step six). For each of the department's particular decision-making processes, a general classification of the different phases in the six-step decision-making model can be made. The acquisition process, for example, has its own procedure that can separately be categorized in the six steps of the model presented.

Comparing the reviewed literature to the findings of the decision factors for AI technology implementation confirmed the statement about AI still being in the introductory phase. The factors that impact firms when choosing an AI tool are comparable across industries – a real estate company's approach is no different than the general described process. The discussed innovation theory in chapter 2.2.3. matches the process the interviewed company goes through while deciding whether to implement an AI system or not. The implementation is a complex process and the link of the new technology to the existing systems can be challenging. Thus, in the long-term, the company will benefit from the use and support of AI. However, one of the reasons why AI has yet to be integrated in a variety of real estate activities is that the data is not available in a form that makes it worthwhile to invest in. In some countries, market data

is difficult to obtain, costly, and the data quality is insufficient. Individual process stages cannot be outsourced to AI since the company's in-house database is limited.

Additional AI application areas have been found, but the company and the market are not yet ready to deploy them substantially. In case sufficient data is accessible and affordable, data quality is reasonably good, and structured data is available, market research could benefit from using AI. A business application that could be interesting for the company to look at is using ML for risk prediction, which has been proven to be helpful in the past, according to the reviewed literature. Another area where AI can be supportive is monitoring safety. The manager of the IT security department stated that the company is already looking into the options of implementing AI into this area. The goal is to cover topics that can be better mapped with AI for the future and simplify all the data and traffic, which is particularly massive in and constantly growing in the field of IT security. Humans are not able to detect the threats in the same way AI could, making AI almost indispensable in the security sector in the future. There are several other areas where AI is used in the real estate sector, however, the expansion of the systems and the final implementation will be continuously improved in the future and will enable the company to adopt it more effectively.

5.2. Limitations

Like any empirical study, the underlying analysis and outcomes contain substantial limitations (Graebner et al., 2012). Foremost, due to the dissertation's limited duration, the consideration of only one company, and the size of the sample of interviews, the information is insufficient to generalize the results across the whole sector. Furthermore, the influence of AI on the success of a real estate company cannot be assessed due to a lack of long-term statistics on the use of AI in the industry. Also, the results are likely to suffer from responder bias and post-hoc rationalization, due to the research methodology, which includes interviews. The responder bias refers to participants answering questions incorrectly to present oneself favorably. Also, any feature of an experimental condition can influence a respondent's answer. (Gupta & Thornton, 2002) Post hoc rationalizations are justifications for acts generated by the brain to justify what has already happened (Blanton et al., 2007). Nonetheless, this sort of research proved useful in gaining insights into how AI tools can be applied in various stages of the decision-making process in a real estate company. Despite the company’s reluctance to reveal information regarding their use of AI in the process, the research gave a better knowledge of

the present status of the technology's deployment, the benefits gained, and the problems associated with its adoption. However, deeper quantitative research is required to determine the benefit of AI over the traditional approach of decision-making in real estate businesses.

5.3. Future Research and Conclusion

The results of the dissertation show that AI can improve the decision-making process of a real estate company. However, it is unclear whether investing in AI is worthwhile in the real estate sector. The advantages that AI offers have already been discussed, but the underlying research provides no results about the impact of AI on the returns. As a result, no definitive conclusion can be drawn, and the impact should be examined further in the future. A quantitative study could be conducted to see the impact of the implemented AI tool on the different projects as well as the return of the whole company. Other future studies could take a number of different directions. By looking at a larger sample of companies in the real estate sector and also in different countries more insights can be generated, and the findings can be validated. Moreover, empirical research is needed to determine when the costs of incorporating AI into the process are justifiable compared to the outcome.

To conclude, the underlying research presents a contribution to the academic literature by evaluating the previously unexplored possibilities of AI in the decision-making processes of a real estate company and providing some future research directions. Within the next few years, AI is going to play a more central role. Further research will determine if the findings of the underlying dissertation are part of a trend, or whether AI systems will be able to deliver long-term benefits to real estate companies in the future.

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7. Appendix

Appendix 1: Interview Guide English Version

Part I: Introduction

Hello [name],

Thank you for agreeing to this interview, I really appreciate it. For the purpose of accurately recording the information you provide, the interview will be recorded, do you agree with that? Furthermore, I assure that all information within the scope of the study will be treated confidentially and anonymously. The aim of the interview is merely academic. If you are interested in receiving the results of the research, I am happy to provide you my dissertation as soon as it is done.

I am trying to get a better understanding of how artificial intelligence is impacting the decision-making process of real estate decisions. I am focusing on the real estate market, and therefore your company fits perfectly in the field of research. While answering the questions, I kindly ask you to give as much detail as possible.

1. Before we get started, could you please give a quick introduction of your company and your role in the company?
2. What is the position of your company in the Real Estate market?

Part II: The Decision-Making Process (Key Questions)

I would now like to move on to the decision-making process.

1. How is the decision-making process structured in your department?
2. What challenges are you facing during that process? Please specify the main challenges for each stage of the decision-making process.
3. In what stages of the process are AI tools already implicated? Which AI tools are currently used?
4. How are these systems helping to solve the challenges that were previously discussed?
5. What opportunities are provided as a result of using AI?
6. Could you please specify how you developed the technology? Was it established in-house or through another company (outsourced)?

7. What challenges did you face by implementing the new technologies in your decision-making process?
8. Please indicate from strongly agree to strongly disagree (1 to 5):
    a. Using AI helped a lot in the decision-making process.
    b. My team is able to reach decisions faster.
    c. The decisions taken using AI are not questioned.
    d. Without AI there are more alternatives considered in the decision-making process.
    e. The overall performance of the company improved due to the usage of AI tools in the decision-making process.
    f. Thanks to the AI systems, the right/correct decisions were made in the past.
9. Is the use of AI tools an add-on to support humans' decisions or are you replacing humans?
10. What decisions are you willing to permit computer systems to make autonomously? What decisions are you not willing to let AI decide autonomously and why?

Part III: Trends and Outlook

1. What are the biggest risks and threats / challenges for your company basing decisions on AI systems? How can they be solved?
2. How much do you think will change regarding the decision-making process in the future? Will AI tools replace humans in parts of the decision-making process?
3. Are you hoping AI will expand in the future in your company? Or not?
4. Do you think the use of AI differentiates you from your competitors in the real estate market?

Part IV: Conclusion

Before we finish, is there anything that you would like to add or that I forgot to ask about?

Thank you for your time. Have a nice day.

Appendix 2: Interview Guide German Version

Teil I: Einleitung

Hallo [Name],

Vielen Dank, dass Sie sich zu diesem Gespräch bereit erklärt haben, ich weiß das sehr zu schätzen. Um die von Ihnen gemachten Angaben genau zu erfassen, wird das Interview aufgezeichnet, sind Sie damit einverstanden? Außerdem versichere ich Ihnen, dass alle Angaben im Rahmen der Studie auf Wunsch vertraulich und anonym behandelt werden. Das Ziel des Interviews ist rein akademisch. Wenn Sie an den Forschungsergebnissen interessiert sind, stelle ich Ihnen gerne meine Dissertation zur Verfügung, sobald sie fertiggestellt ist.

Ich versuche ein besseres Verständnis dafür zu bekommen, wie künstliche Intelligenz den Entscheidungsprozess von Immobilienentwicklungs-/Investitionsentscheidungen beeinflusst. Ich konzentriere mich auf den Immobilienmarkt, und daher passt Ihr Unternehmen perfekt in das Forschungsgebiet. Bei der Beantwortung der Fragen bitte ich Sie, so detailliert wie möglich zu sein.

1. Bevor wir beginnen, könnten Sie bitte kurz Ihr Unternehmen und Ihre Rolle im Unternehmen vorstellen?
2. Wie ist die Position Ihres Unternehmens auf dem Immobilienmarkt?

Teil II: Der Entscheidungsfindungsprozess (Schlüsselfragen)

Ich möchte nun zum Entscheidungsprozess übergehen.

1. Wie ist der Entscheidungsprozess in Ihrer Abteilung strukturiert?
2. Mit welchen Herausforderungen sind Sie während dieses Prozesses konfrontiert? Bitte nennen Sie die wichtigsten Herausforderungen des Entscheidungsprozesses.
3. In welchen Phasen des Prozesses werden bereits KI-Tools eingesetzt? Welche KI-Tools werden derzeit eingesetzt?
4. Wie tragen diese Systeme zur Lösung der zuvor erörterten Herausforderungen bei?
5. Welche Chancen ergeben sich aus dem Einsatz von KI?
6. Können Sie bitte angeben, wie Sie die Technologie entwickelt haben? Wurde sie intern entwickelt oder durch ein anderes Unternehmen (ausgelagert)?
7. Vor welchen Herausforderungen standen Sie bei der Umsetzung der neuen Technologien in Ihrem Entscheidungsprozess?
8. Bitte geben Sie an, ob Sie voll und ganz zustimmen oder überhaupt nicht zustimmen:

a. Der Einsatz von KI war eine große Hilfe bei der Entscheidungsfindung.

b. Mein Team ist in der Lage, Entscheidungen schneller zu treffen.

c. Die mit KI getroffenen Entscheidungen werden nicht in Frage gestellt.

d. Ohne KI werden mehr Alternativen im Entscheidungsprozess berücksichtigt.

e. Die Gesamtleistung des Unternehmens hat sich durch den Einsatz von KI-Tools im Entscheidungsprozess verbessert.

f. Dank der KI-Systeme wurden in der Vergangenheit die richtigen/korrekten Entscheidungen getroffen.

9. Ist der Einsatz von KI-Tools eine Ergänzung zur Unterstützung menschlicher Entscheidungen oder ersetzen Sie den Menschen?
10. Welche Entscheidungen sind Sie bereit, Computersystemen zu erlauben, selbständig zu entscheiden? Welche Entscheidungen wollen Sie nicht von KI autonom treffen lassen und warum?

Teil III: Trends und Ausblick

1. Was sind die größten Risiken und Bedrohungen/Herausforderungen für Ihr Unternehmen, das Entscheidungen auf KI-Systeme stützt? Wie können sie gelöst werden?
2. Wie sehr wird sich Ihrer Meinung nach der Entscheidungsprozess in der Zukunft verändern? Werden KI-Tools den Menschen in Teilen des Entscheidungsprozesses ersetzen?
3. Hoffen Sie, dass sich KI in Zukunft in Ihrem Unternehmen ausbreiten wird? Oder nicht?
4. Glauben Sie, dass Sie sich durch den Einsatz von KI von Ihren Mitbewerbern auf dem Immobilienmarkt unterscheiden?

Teil IV: Schlussfolgerung

Möchten Sie noch etwas hinzufügen oder habe ich etwas vergessen zu fragen?

Ich danke Ihnen für Ihre Zeit. Ich wünsche Ihnen einen schönen Tag.

Appendix 3: Overview Main Findings

4.1.	Structure of decision-making process
	- Start: Purchase of property - Core Business: construction process - Several phases (acquisition, preparation, planning, implementation, closing) - Framework and profile of requirements - Planers and partners involved - Rework loops and flexibility for alternative solutions - Final draft - Close coordination during construction process - Final inspection - Long-term projects (up to 10 years)
4.2.	Challenges in the decision-making process
	- Huge amount of data - Scarcity of available market data, non-transparent - A lot of competition and not enough supply - Coordinate and synchronize demand - Recognize risks and errors - Compliance with deadlines, costs, and quality standards - Clear framework and definition of requirements - Ensure security - Good communication - Harmonize and coordinate planning activities
4.3.	Use of AI in the decision-making process
4.3.1.	Decision Factors
	- Strategic investments - Problem identifications and pain points - Solution is looked for in market - Testing phase before implementation - Sufficient available data and good data quality
4.3.2.	What AI is currently used for
	- Intelligent Decision Support Tool - To identify risks - Electronic invoices - Ensure data quality of machines - IT security - Suggestions - Improvement of process - Data preparation
4.3.3.	Challenges using AI
	- Data volume - How to get the data - How data transfer takes place - Data protection - Link to companies database

	- Mistakes of AI - Consider exceptions - Error tolerance
4.3.3.	Opportunities using AI
	- Identify problems early on and avoid crisis - Speed - faster decisions - Time-saving - Employees have more time for other tasks - Reduce work - Accuracy - accurate decisions - More efficient - Support - More sustainable (not so much paper anymore - digital)
4.3.4.	Autonomous decisions
	- Cannot solve problems completely autonomous at the moment - Support decisions - Gives recommendations - Final decisions are still made by humans - No replacement of humans - Human still either post process information or react on what AI prepared
4.3.5.	Outlook and future trends
	- Increased learning curve of AI systems - Will become more efficient - Error susceptibility could go against zero with AI - Humans it will always remain at the same error rate - Every company will use AI sooner or later - More processes supported by AI in companies - Human characteristics should not be lost – like emotion - AI as a solution for unmanageable data

Appendix 4: Quotes of the Main Findings

4.1.	Structure of decision-making process
	- "In the beginning there is the project idea and behind every big investment decision there is the need and the necessity." (Interview 7) - "Before the purchase process, the portfolio is defined as it looks now and as it should look in the future - in between there is a gap - with an investment strategy we try to close the gap." (Interview 10) - "The construction process, the core business of the company, basically consists of five main phases, which are acquisition, preparation, planning, implementation and closing." (Interview 4) - "A project can last up to (or over) 10 years. Meanwhile, there are effects on the project, e.g., something evolves. We try to incorporate these changes and adjustments through the rework loops and alternative solutions during the project." (Interview 7)
4.2.	Challenges in the decision-making process
	- "Generally, in the real estate market, a huge challenge is market transparency - it is opaque and little market data and transaction data is available." (Interview 10) - "One of the biggest challenges in the decision-making process is recognizing the risks at an early stage." (Interview 4) - "Data is gigantic, hardly any human can sift through it - AIs are already very strong in this respect." (Interview 5) - "The compliance with deadlines, costs, and quality standards is another challenge that we are facing in every decision we are making." (Interview 4) - "Clarity of the framework conditions at the beginning are very important. In the beginning, enough time must be invested to know and ensure that what you want is the right thing and that the framework is well formulated." (Interview 7) - "As there might be things that are overlooked – good communication is essential in the process to ensure good cooperation and avoid unnecessary scandals." (Interview 4) - "One challenge is to harmonize and coordinate planning. Collaboration to make decisions early and to recognize errors so that they do not reach the construction site." (Interview 2)
4.3.	Use of AI in the decision-making process
4.3.1.	Decision Factors
	- "We do not make investments that are purely about returns. I start with a problem that arises in the Group and go looking for a solution. We know where the pain points are and look for answers on the market." (Interview 9) - "Architecture is a creative process - it should not be stifled by algorithms or systems. In this way, what architecture actually might get lost." (Interview 3) - "One problem is that there are so many providers on the market - to check them all is difficult and consumes a lot of time. So, the selection of service providers and the right product is difficult in my opinion." (Interview 5) - "Data is not (yet) available in a form that makes sense to invest in AI. Market data is difficult to access, expensive, and of poor quality." (Interview 10)

4.3.2.	What AI is currently used for
	- "Work is underway to convert paper invoices to electronically structured format. The intention is to purchase one of these solutions if it is convincing." (Interview 5) - "We already use artificial intelligence since last year in the area of data management and data quality." (Interview 6) - "The information generated during the project (for example emails or other information exchanges) is read by an AI and the AI recognizes emotions, which are then clustered and directed. The system is tested to better assess the risk for future projects." (Interview 4) - "In the IT security area, topics that can be better mapped with AI for the future. This is another sector where AI is currently tested." (Interview 5)
4.3.3.	Challenges using AI
	- "Solutions are offered that must be further developed when errors occur. Errors are not evil, but one must be grateful that they have now been discovered." (Interview 3) - "To ensure data quality and have enough data available, data collection must take place in all areas of the company." (Interview 6) - "Error tolerance must be given - this would then be solved by the human still being behind it and looking over it again." (Interview 5) - "A challenge using the new technology is linking the external software with our databases so that it really comes out with added value." (Interview 6) - "The risk of using AI is that decisions are made incorrectly that humans might have made differently due to their extra capabilities." (Interview 10) - "Where the AI has many repetitions and a similar pattern it works really well, but the problem are exceptions - there the data could not be read by AI." (Interview 5)
4.3.3.	Opportunities using AI
	- "You become safer and faster with AI – way, way faster." (Interview 5) - "Humans can't read everything, every email, etc., and the support of AI gives a basis to show the potential for conflict and avoid risks (or even a crisis) at an early stage of the project." (Interview 7) - "A system that supports the human helps to save time and reduce the work in a certain area, which makes more time available for other important tasks." (Interview 7) - "Of course, becoming more efficient also means saving costs, and of course it also means becoming cheaper and thus being able to offer better prices to customers." (Interview 5)
4.3.4.	Autonomous decisions
	- "I personally think it rather is the human factor trying to prevent autonomous decision making, because then we have no or less control, but I think that will still happen sooner or later in some areas." (Interview 9) - "Currently, the AI would not take over decisions but support humans – it would support or prevent situations from arising and help to be able to react early to things that would later lead to problematic decisions." (Interview 4) - "It is conceivable that the AI pre-assesses decisions and that recommendations are made." (Interview 4)

	- "The AI cannot solve problems completely autonomous at the moment, you still have to control the outcome of the AI, like the post-processing of the electronic invoices and in case of security software you then still have to react to the outcome." (Interview 5)
4.3.5.	Outlook and future trends
	- "In the future, more or other processes will certainly be supported by AI." (Interview 5) - "AI may play a role in risk management in the future, as the amount of data gets bigger, the developments faster and the insights more and more. The prerequisite for this is suitable data quality and the availability of the data." (Interview 8) - "At least sub-processes in many areas may be replaced by an AI - as soon as processes are standardized, this will probably be more possible." (Interview 9) - "The human makes mistakes, just like an AI tool sometimes - the question that poses itself to me is rather who makes fewer mistakes. If the AI works correctly then the error susceptibility is with the AI against 0 and with humans, it will always remain the same. Thus, there will certainly be an advantage in the direction of AI." (Interview 6) - "These systems (AI) must be continuously challenged to learn, and they can then be further adapted to become more efficient." (Interview 3) - "Not only rationality flows into a decision, but also emotion. This human emotion would be lost through AI." (Interview 8)